

REMARKS

This Amendment is in response to the Office Action dated March 28, 2006. Applicant acknowledges with appreciation the withdrawal of the objection to the abstract and the withdrawal of the previous prior art rejections in light of the previous claim amendments.

In this Response, Applicant amends claims 2, 8, 18 and 20, as described in detail below. Upon entry of this Amendment, Claims 1-20 are pending and under consideration.

Claim Rejections Under 35 USC §112

The Examiner rejects claims 1 – 20 under 35 USC §112, first paragraph, as failing to comply with the written description requirement. Applicant respectfully traverses and submits that the amended claims are fully supported by the written description.

Claims 2 and 20 are amended to recite that the film exhibits uniformity of $< 2\% 1\sigma$. Support for this amendment is found in the specification, specifically at page 6, lines 12 – 13.

Claim 8 is amended depend from claim 5 and to recite the nitrogen source precursor introduced at a flow rate of about 10 to 10,000 sccm. Support for this amendment is found specifically at page 5, lines 28 – 30 of the specification.

Claim 18 is amended to recite a deposition rate of about 500 Angstrom. Support for this amendment is found specifically in the specification at page 6, lines 17 – 18 and at page 8, lines 7 – 8.

Applicant respectfully submits that these amendments do not add new matter, and requests that the rejection under 35 USC §112, first paragraph be withdrawn.

Claim Rejections Under 35 USC §103

The Examiner rejects Claims 1 – 20 under 35 USC §103(a) as allegedly unpatentable over Balsan. The Examiner further rejects Claims 1 – 20 under 35 USC §103(a) as allegedly

unpatentable over Hurley. Applicant respectfully disagrees and traverses these rejections, and submits that the present claims are patentable in light of the cited references.

To establish a proper prima facie case of obviousness, three criteria must be met. First, there must be some suggestion or motivation, either in the cited references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify or combine the cited reference relied upon by the Examiner to arrive at the claimed invention. Second, there must be a reasonable expectation that the suggested modification or combination would be successful. Finally, the prior art reference (or references when combined) must teach or suggest each and every limitation of the rejected claims. The teaching or suggestion to make the claimed modification or combination and the reasonable expectation of success must both be found in the prior art, and not based upon in the applicant's disclosure. M.P.E.P. §706.02. Applicants respectfully submit that a prima facie obviousness has not been established and the inventions recited in instant Claims 1-20 are patentable over Balsan and Hurley.

Balsan is directed to a method of depositing a conformal, hydrogen-rich silicon nitride layer on a patterned structure. Balsan discusses a first embodiment using a Rapid Thermal CVD technique in a cold wall single wafer reactor (see paragraph 0074). Balsan discloses very high processing temperatures:

“[0077] It is now possible to use the SACVD Centura tool with a SiH_4 based chemistry at a temperature and pressure in the 600 – 950 °C. and 50-200 Torr ranges respectively.”

“[0078] More specifically, when the AME Centura tool is used with SiH_4/NH_3 chemistry, Si_3N_4 barrier layer 21 fully expected characteristics are obtained by setting the temperature and the pressure at about 785 °C and 90 Torr respectively. ...”

Balsan discusses in a second embodiment using LPCVD equipment which is a hot wall wafer batch reactor at paragraph 0081. Balsan describes carrying the out at a deposition

temperature below 700 °C, and shows a deposition temperature of 650 °C in the Table following paragraph 0082.

In significant contrast to the present invention, Balsan describes a low deposition rate, specifically:

“[0084] The very low deposition rate of the LPCVD process (about 0.7 nm/min) has a significant impact on cycle time, but if it represents a penalty for OEM manufacturing (e.g. EDRAM chips) it is greatly advantageous in fabricating SDRAM chips because it is a mass production. In the same working conditions, the SiH_4/NH_3 chemistry has a higher deposition rate but is not recommended in a batch furnace because it induces stresses and thickness non-uniformity in the Si_3N_4 deposited material.”

Hurley is directed to a silicon nitride method including providing a substrate surface including one or more component surfaces. At least a monolayer of silicon is predeposited on the one or more component surfaces of the substrate surface, and thereafter a silicon nitride layer is deposited on the predeposited silicon substrate (see Abstract).

At column 4, lines 6 – 22, Hurley describes forming of the silicon nitride layer :

“Conventional methods are then typically used for forming a silicon nitride layer on the oxide free wafer surface as represented by block 14 in FIG. 1. Such conventional methods may include growing a silicon nitride film on silicon by reacting nitrogen or a nitrogen compound, such as ammonia (NH_3) with surface silicon atoms at elevated temperatures, typically 900 °C to 1300 °C. ... The deposition rate increases rapidly with temperature. While the rate of deposition at 700 °C may be less than 1 nm/min, it may increase to 100 – 200 nm/min at 900 °C. The deposition rates will vary depending upon

various conditions of the deposition as is well known to one skilled in the art.”

Hurley further references LPCVD processes at column 4, lines 23 – 36 and recites “the reaction of dichlorosilane (DCS) and ammonia (NH₃) at a temperature of about 700 °C. to 800 °C. to deposit the silicon nitride film.”

Applicants claimed invention differs significantly. Indeed, Applicants claims recite a method carried out at a temperature of up to approximately 550 °C, or in a range of 400 °C to 550 °C, while achieving very high deposition rates. This is quite an unexpected result, and would not be expected given the teachings of Balsan and Hurley. In fact, Hurley teaches that the deposition rate increases rapidly with temperature, and states that while the rate of deposition at 700 °C may be less than 1 nm/min, it may increase to 100 – 200 nm/min at 900 °C. Thus, at best Hurley is saying one could achieve the equivalent of 10 Angstroms/min (*i.e.* 1nm/min) at 700 °C. Moreover Hurley teaches that you would have to operate at a very high temperature of 900 °C in order to achieve the deposition rate recited in the present invention. Thus, Hurley teaches away from the present invention where such high deposition rates are achieved at a low temperature range of 400 °C to 550°C as recited in Applicants claims. Balsan also recites a low deposition rate for the LPCVD process of about 0.7 nm/min (or 7 Angstroms/min).

The method of the present invention is not mere optimization. Such a significant increase in deposition rate while lowering the temperature is contrary to conventional understanding and the prior art teaching. Deposition processes are quite complex and vary widely depending on the process conditions, chemicals used and equipment employed, among other variables. Significant experimentation is required. Applicant respectfully submits that one of ordinary skill cannot be expected to arrive at the present invention given the wide range of variable such as the types of precursors, ratios of the precursors, reaction temperatures, reactor configuration, pressures and other conditions in a complex CVD process. Very significant experimentation – much more than routine experimentation – would be required. Applicant respectfully submits that a prima facie case has not been established with respect to the cited references, and that the present claims are patentable over the cited art.

Based on the foregoing, Applicants respectfully submit that the application is now in condition for allowance. If any matters can be resolved by telephone, the Examiner is invited to call the undersigned attorney at the telephone number listed below. The Commissioner is authorized to charge any additional fees to Deposit Account No. 50-2319 (Order No. A-71730/MSS (463035-878)).

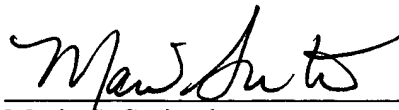
Respectfully submitted,

DORSEY & WHITNEY LLP

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Customer No. 32940
Dorsey & Whitney, LLP
Intellectual Property Department
555 California Street, Suite 1000
San Francisco, CA 94104-1513
(650) 757-1717 (telephone)
(650) 857-1288 (facsimile)

By:



Maria S. Swiatek
Registration No. 37,244